Assessing the Effectiveness of a Voluntary Bycatch Avoidance Program: Sea State

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Our Research Objective

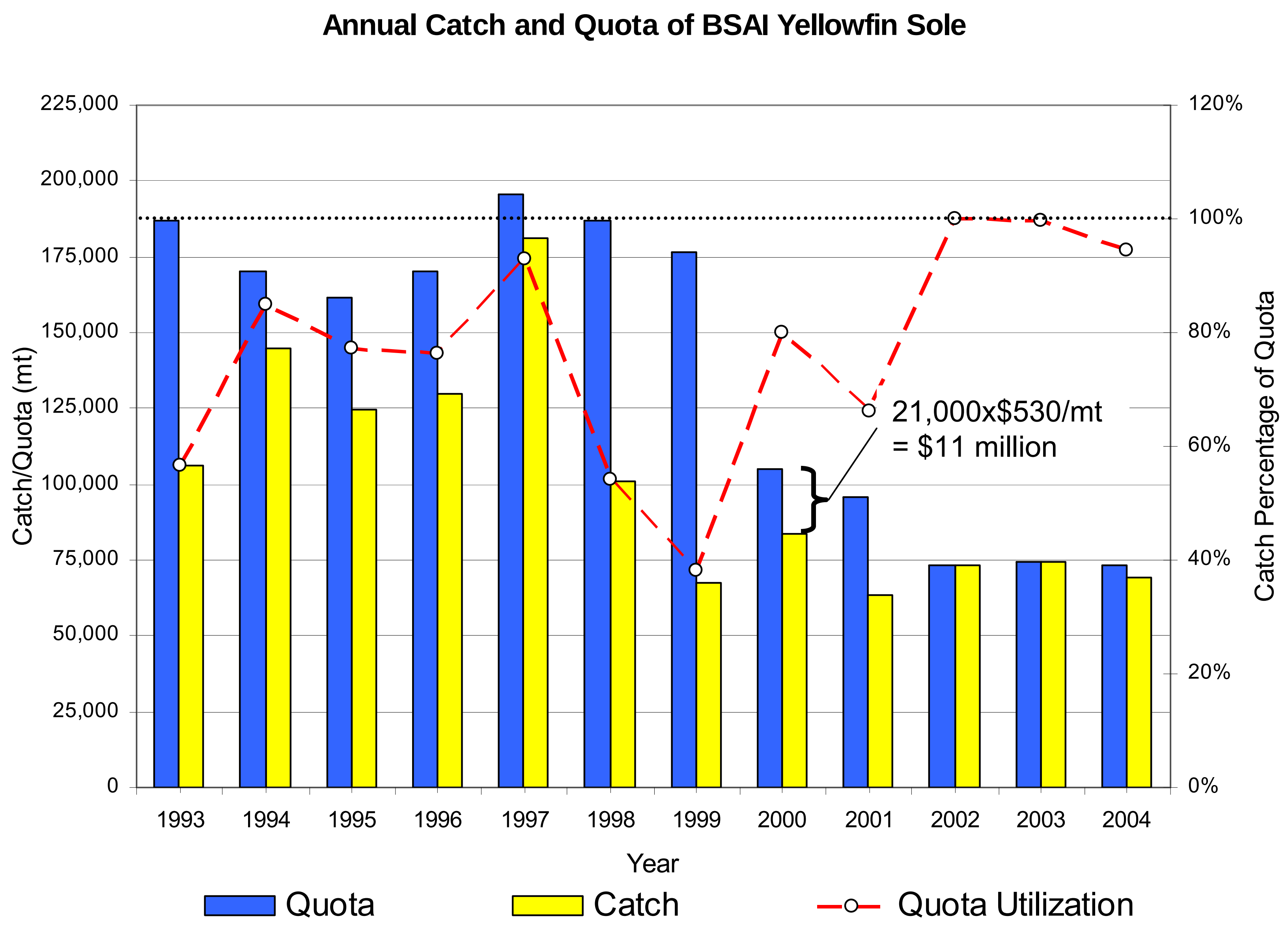
- Examine the performance of a voluntary bycatch avoidance program among EBS trawlers.
  - Institutional framework: common property quotas
- Did membership in the program alter:
  - Bycatch outcomes (reduced form modeling)?
  - Bycatch-influencing behaviors (spatial structural modeling)?
- Key feature: before/after data and participant/non-participant vessels

The EBS Head-and-Gut Trawl Fishery

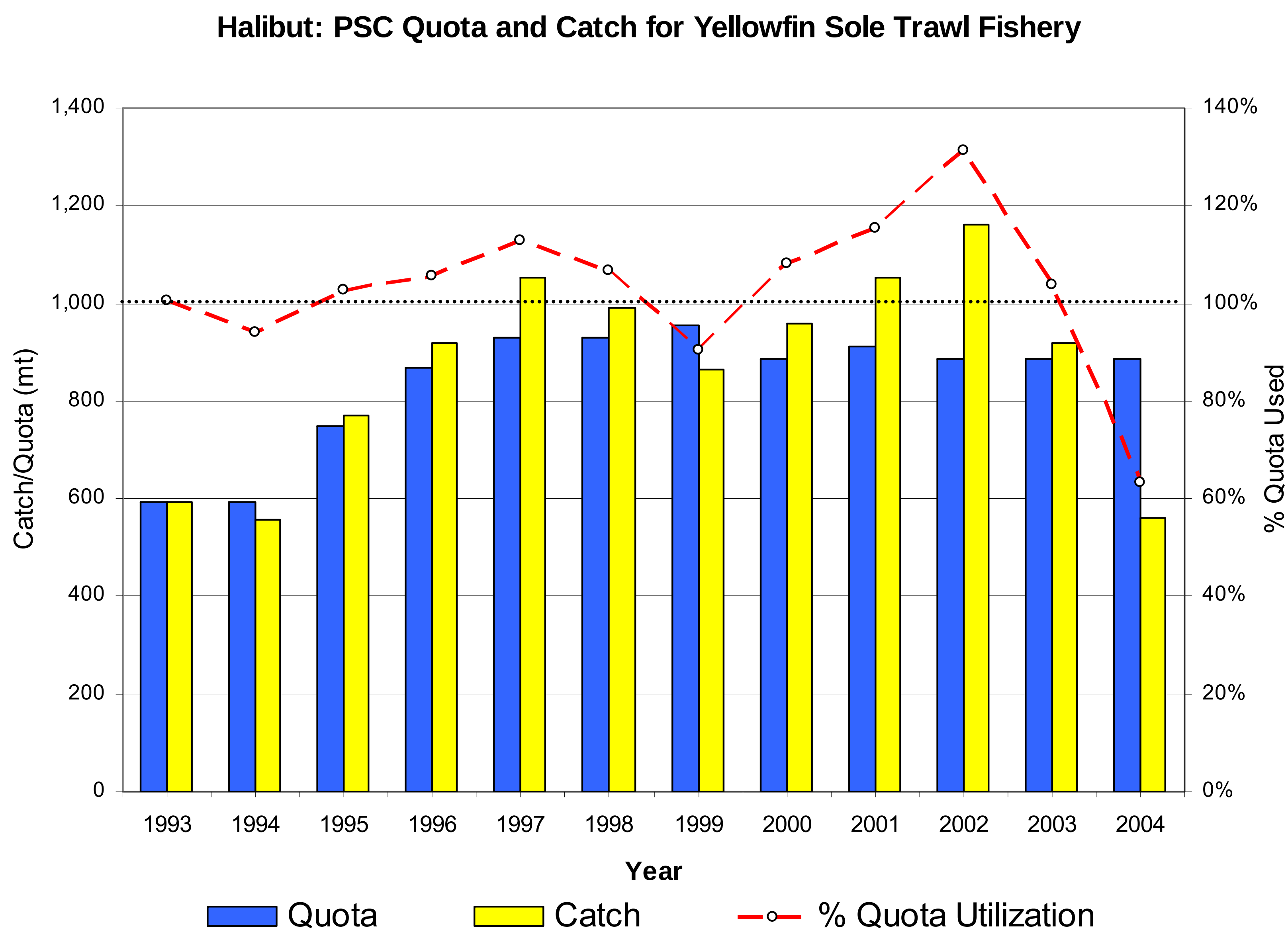
- Comprised of ~20 catcher-processor vessels
  - Owned by ~10 companies
  - 100-225 ft. in length
  - Conduct limited onboard processing
  - Utilize non-selective bottom trawl gear
- Regulated by a complex system of time/area closures, retention restrictions and common property catch & bycatch quotas on:
  - Target Species: yellowfin, rock and flathead sole, cod, rockfish
  - Prohibited Species: Pacific halibut and some crab species

Common Property Bycatch Quotas

- Prohibited species catch (PSC) must be discarded
- Regulators curtail the retention of target species when PSC quotas are exceeded
- Spatial co-occurrence of target and bycatch species makes avoidance costly
  - Avoidance costs are personally born but the benefits are diffuse across the fleet
- Result: a “race for bycatch”
  - Abbott & Wilen (forthcoming)



Annual Catch and Quota of BSAI Yellowfin Sole
225,000
200,000
175,000
150,000
125,000
100,000
75,000
50,000
25,000
0
Catch/Quota (mt)
120%
100%
80%
60%
40%
20%
0%
Catch Percentage of Quota
21,000x$530/mt
= $11 million
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Quota
Catch
Quota Utilization



Halibut: PSC Quota and Catch for Yellowfin Sole Trawl Fishery
1,400
1,200
1,000
800
600
400
200
0
Catch/Quota (mt)
140%
120%
100%
80%
60%
40%
20%
0%
% Quota Used
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
Year
Quota
Catch
% Quota Utilization

The "Voluntary" Solution: Sea State

- In 1995, a group of fishermen retained Sea State Inc. to provide near real-time updates on bycatch rates for the yellowfin and rock sole fisheries.
- Participating fishermen were given a daily spatial summary of bycatch rates in the fishery.
  - Anonymous, but only partially
- Fishermen could use the information to avoid bycatch "hot spots" and pressure other fishermen to do the same.

- Important: a small number of vessels (from one company) <u>did not participate</u> in Sea State until ~1999.

Did Sea State work?

- Some early successes
  - Seven-fold decrease in red king crab bycatch in 1995 (Gauvin, Haflinger and Nerini, 1995)
  - Little discussion of results for Pacific halibut
- We examine this question in several ways
  - Outcome based (quasi-experimental methods)
  - Behavior based (structural modeling of fishing location choice)

Data

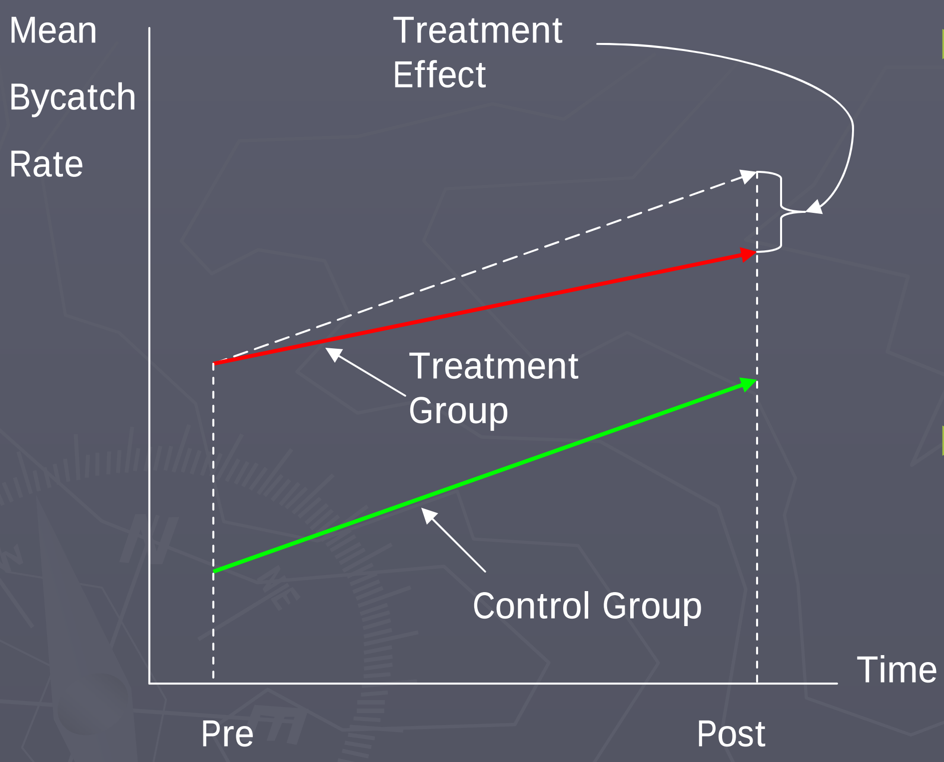
- North Pacific Observer Database 1992-2000
  - All vessels over 124 feet must carry an observer on all trips.
  - Observers record the precise spatial location and duration of each haul.
  - A random sub-sample is selected for species-composition sampling (including bycatch species)
  - The sampling of hauls is designed to minimize incentive problems and measurement error.
- Final sample
  - 1992 to 2000, April to November
  - 18 vessels with 100% observer coverage
  - 2784 vessel-weeks in sample

Table 6.1: Quantiles and other Summary Statistics for Weekly Halibut/Groundfish Bycatch Rates (kg/mt)

Year		10%	25%	50%	75%	90%	Mean	Wilcoxon Rank-Sum z Statistic
1992	Sea State	0	0	0.9	6.5	16.8	5.8	
	Non-Sea State	0	0	2.1	7.3	16.6	6.1	1.04
	All	0	0	1.4	7.2	16.7	5.9	
1993	Sea State	0	0.4	2.4	7.4	16.5	6.0	
	Non-Sea State	0	0	2.0	13.5	31.3	10.7	0.64
	All	0	0.1	2.2	9.1	21.5	7.9	
1994	Sea State	0	0	1.6	8.1	21.1	8.9	
	Non-Sea State	0	0	1.1	9.5	27.7	12.3	-0.06
	All	0	0	1.5	8.2	25.1	10.4	
1995	Sea State	0	0	1.9	11.3	30.2	12.0	
	Non-Sea State	0	0	1.2	17.1	31.6	10.9	-1.02
	All	0	0	1.4	11.8	30.3	11.7	
1996	Sea State	0	0.7	5.6	13.8	31.0	11.8	
	Non-Sea State	0	0	2.9	13.2	27.4	9.3	-1.76*
	All	0	0.2	4.5	13.3	30.0	10.9	
1997	Sea State	0	1.0	3.8	10.7	28.9	9.9	
	Non-Sea State	0	0.7	3.8	11.6	26.1	9.7	-0.54
	All	0	0.9	3.8	10.8	27.4	9.8	
1998	Sea State	2.0	5.7	12.6	21.0	34.3	19.7	
	Non-Sea State	0	0.2	3.9	10.7	22.7	7.9	-7.2**
	All	0	2.5	8.8	17.5	30.4	14.7	
1999	Sea State	2.0	6.5	15.2	32.4	62.8	26.6	
	Non-Sea State	0.1	0.5	6.2	26.0	41.3	15.8	-3.14**
	All	0.4	4.2	14.0	31.4	55.9	23.5	
2000	Sea State	1.1	6.2	16.4	33.0	57.4	24.1	
	Non-Sea State	0	0.9	6.1	10.7	18.4	7.5	-7.31**
	All	0	3.0	10.4	24.5	40.9	17.9	

*Significant at the 10% level of significance
**Significant beyond the 1% level of significance

"Difference in Differences"



- The average "treatment effect" of the program is the change in the bycatch rate for the "treated" vessels minus the change in the bycatch rate for the "control" (non Sea State) vessels
- Assumptions
  - Treatment and control groups are temporally stable
  - Treatment and control groups must be "similar"
  - The assignment of the treatment must be "exogenous"

$$y_{it} = \beta_0 + \beta_1 d_t + \beta_2 d_i + \beta_3 (d_t * d_i) + \varepsilon_{it}$$

A "Modified DID" Approach

- We alter the specification to allow for
  - Year specific treatment effects
  - Vessel characteristics
- We estimate 3 variations on the model
  - Model 1 – as above
  - Model 2 – seasonal effects
  - Model 3 – vessel specific intercepts
- The standard errors are robust to vessel-specific heteroskedasticity, contemporaneous correlation across vessels and AR(1) correlation within panels

DID Results

	Model 1	Model 2	Model 3
Sea State*1995	4.72	4.11	5.04
	(0.91)	(0.84)	(1.03)
Sea State*1996	5.70	5.69	6.80
	(1.08)	(1.14)	(1.32)
Sea State*1997	2.73	3.09	4.21
	(0.65)	(0.79)	(1.01)
Sea State*1998	17.12	18.27	18.49
	(3.86)***	(4.40)***	(4.22)***
Sea State*1999	13.30	14.86	16.40
	(2.60)***	(3.02)***	(3.10)***
Sea State*2000	20.61	21.47	22.83
	(4.54)***	(5.04)***	(4.77)***
Constant	10.77	17.92	30.45
	(3.03)***	(4.72)***	(2.92)***
Observations	2784	2784	2784
R-squared	0.06	0.09	0.1

DID – Beyond the Mean

- There are reasons to be dissatisfied with these results:
  - The conditional mean may not describe “typical” bycatch behavior.
  - Linear regression is sensitive to outliers.
  - The effect of Sea State could operate on other aspects of the bycatch distribution.
- To examine these possibilities we estimate DID specifications of the conditional quantiles.
  - Censored quantile regression
- Result: the mean results are mirrored by the entire distribution of outcomes.

"Outcome Based" Methods – Limitations

- Bycatch rates represent the interface of fishermen's preferences <u>and</u> the biological, economic and regulatory constraints they face.
- Output based methods run the risk of confounding outcomes and incentives
- Answer: explicitly model the short-run margin of bycatch avoidance
  - Spatial choice

A Random Utility Model of Fishing Location

- Short run profitability and catch composition are primarily driven by the decision of where to fish.
- We represent the expected utility of a particular site (*n*) for a particular haul of the net (*t*) as:

$$U_{nt} = \beta * E\left(\frac{REV_{nt}}{HR}\right) - \gamma * DIST_{nt} - \lambda * E\left(\frac{HALIBUT_{nt}}{HR}\right) + \delta' X_{nt} + u_{nt},$$

Expected revenues per standardized hour of towing

Distance from current location

Expected halibut bycatch (kg) per standardized hour of towing

Control variables

Unobserved factors

Random Utility, cont.

- λ/β=the "shadow cost" of bycatch
  - The implicit willingness to avoid bycatch revealed by fishermen's spatial tradeoffs
- By parameterizing λ using the "difference in differences" approach we can examine the effect of Sea State on fishermen's tradeoff incentives

$$\lambda_{it} = \gamma_0 + \gamma_1 SeaState_i + \gamma_2 AfterSS_t + \gamma_3 After1998_t + \ldots$$
$$+ \gamma_4 (AfterSS_t * SeaState_i) + \gamma_5 (After1998_t * SeaState_i) + Z'_{it}\delta$$

	Median	Standard Deviation
AfterSS	-$11.07	$5.11
	(-1.65)	
After1998	$6.00	$2.77
	(1.71)	
AfterSS*Sea State	$3.69	$1.71
	(0.50)	
After1998*Sea State	-$16.27	$7.52
	(-3.32)***	
N	45,200	
Number of Estimated Parameters	115	
Log-likelihood	-20,167	
Pseudo R^2	0.7828	
Predictive R^2	0.8476	

z Statistics are included in parentheses and are all derived using standard errors calculated by the delta method.
*** significant at 1%

Summary

- No detectable incentive effect of Sea State from 1995-1997
- Structural modeling suggests *incentives* to avoid halibut markedly *decreased* for Sea State participants from 1998 onward
- Strong upward trend in bycatch rates by SS participants in late 1990s is linked to a reduction in the implicit value of halibut bycatch
  - Reason: 30% decline in yellowfin prices between 1997/1998
- The reduced form and structural models are consistent & complementary.

Why did Sea State fail?

- Several hypotheses:
  - Weak target fish prices (Holland & Ginter, 2001)
    - Doesn't explain lackluster 1995-1997 performance
  - Increased halibut abundance
    - Doesn't explain lackluster 1995-1997 performance
  - Predatory behavior by (former) non-participants (Gauvin, Haflinger & Nerini, 1995)
    - Just not supported by the data

Why did Sea State fail?

- Noncooperative incentives under management institutions were simply too strong to support voluntary cooperation
- Problem: the success of Sea State for red king crab bycatch avoidance
  - Preliminary results using zero-inflated count models indicate a 40% reduction in crab bycatch.
  - Red king crab is managed under common property quotas just like halibut.

What makes RKC different?

- Fishery is spatially concentrated
  - Lowers monitoring and enforcement costs of cooperative behavior.
- Fishery is short lived
- Large benefits from bycatch avoidance
  - Rock sole roe is a valuable export product
- Spatiotemporal nature of RKC abundance
  - Highly mobile & spatially clustered (Dew, 2007)

Conclusion

- The apparent failure of cooperative halibut bycatch avoidance seems to lie in two factors
  - Bad incentives from the management structure of the fishery
  - The characteristics of the fishery itself
- This suggests that policies aimed at sustaining cooperative management of resource stocks must consider both institutional constraints and the constraints posed by nature itself.